HERE COMES THE SUN

A Guide Book for Massachusetts People Interested in Learning About Solar Energy

THE COMMONWEALTH OF MASSACHUSETTS
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This booklet was prepared to give you a better understanding of solar energy and how it works. Because many different people are interested in solar energy, and have a variety of needs and questions, we have tried to design a booklet which will be useful to all those people and help answer a wide range of questions.

The first section contains some facts on solar energy, while the second goes into more detail about solar systems, and explains how they work. Questions commonly asked about these systems are answered in the third portion. Finally; the last two sections discuss the economics of solar energy and consumer protection. Because the solar energy field changes constantly, we have kept additional information on solar firms, legislation, and background material separate, so that we can update and revise it regularly.

If you are interested in more information on solar energy after reading this booklet, please write or call the Massachusetts Office of Energy Resources.

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TAX INCENTIVE UPDATE

The following revisions have been made in solar and wind tax incentives since the publication of Here Comes the Sun. These descriptions replace the paragraphs on "Federal Income Tax Credit" (p. 16), "State Solar Sales Tax Exemption" (p. 17), and "Solar Income Tax Credit" (p. 17). The paragraph on "Property Tax Exemption" (p. 17) remains the same.

Federal Income Tax Credit

Homeowners and tenants can claim a federal income tax credit of 40% of the installed cost of a solar or wind system, up to a maximum credit of $4,000. Active solar and wind systems which provide heating, cooling, hot water or electricity are eligible for the tax credit. Wood stoves or furnaces, swimming pool heaters, and heat pumps do not qualify. Passive solar systems qualify although only those components whose sole purpose is to transmit or to use solar radiation are eligible for the credit. Thus components that serve a significant structural function, such as walls, skylights, or greenhouses, do not qualify. However, such components as vents, ducts and rock storage bins do qualify.

The 40% credit is available for expenditures made in 1980 and extends through 1985. This credit is subtracted directly from the amount of federal personal income taxes owed (not from net income). Unused credits may be carried over into later tax years through 1987. (H.R. 3919)

State Solar Income Tax Credit

Any owner of residential property located in the Commonwealth who occupies the property as his/her principal residence is allowed an income tax credit of 35% or $1,000, whichever is less, on the installed cost of renewable resource systems. This credit is to be taken on the cost which results after federal tax credits and any grants received have been subtracted from the original cost. The law is effective as of January 1, 1979, and expires on December 31, 1983. The taxpayer may carry over unused credits into the next tax year for up to three years.

Eligibility is similar to the federal tax credit. Active solar and wind systems which provide heating, cooling, hot water or electricity are eligible for the tax credit. Wood stoves or furnaces, swimming pool heaters, and heat pumps do not qualify. Passive solar systems qualify although only those components whose sole purpose is to transmit or to use solar radiation are eligible for the credit. Thus components that serve a significant structural function, such as walls, skylights, or greenhouses, do not qualify. However, such components as vents, ducts and rock storage bins do qualify.

How the Tax Credits Work

In the case of a solar domestic hot water system costing $3,500, the credits would be calculated in the following manner:

Original Cost:	$3,500	
Federal Tax Credit: (40% of original cost $4,000 maximum credit)		
40% of $3,500	-1,400	
	$2,100	Remaining Balance after Federal credit
State Tax Credit: (35% of net expenditure $1,000 maximum credit)		
35% of $2,100	- 735	
	$1,365	Remaining Balance after State credit
TOTAL TAX CREDIT = 61% or in this case	$2,135	

Taking another case where the 35% state tax credit percentage exceeds $1,000 - a domestic wind machine costing $12,000 - the credit would be calculated as follows:

Original Cost:	$12,000	
Federal Tax Credit: (40% of original cost $4,000 maximum credit)		
40% of $12,000	- 4,800	
	$ 7,800	Remaining Balance after Federal credit
State Tax Credit: (35% of Net Expenditure or $1,000, whichever is less)		
35% of $7,200 is greater than $1,000 therefore	- 1,000	
	$ 6,200	Remaining Balance after State credit
TOTAL TAX CREDIT = 52% or in this case	$ 5,800	

State Sales Tax Exemption

Any equipment relating directly to a solar, wind or heat pump system for a person's principal residence is exempt from state sales tax. Also, any wood-fueled heating systems which is the primary heating system for a person's principal residence and which costs more than $900 is exempt from the sales tax. (Mass. G.L.C. 64H, Sec. 6)

Introduction

There is no question that for you, as a Massachusetts homeowner, solar energy is rapidly becoming an attractive alternative to paying ever increasing electricity, gas, and oil bills. Solar energy is simple to use for heat and hot water and has been successfully used for over 20 years in some American homes. Sunlight is plentiful and will not become more expensive or less plentiful in our lifetimes. For many people, solar equipment is a practical and economical energy saving option today, and with rising fuel costs more and more people will be turning to solar energy. This booklet will help you to determine whether solar is right for you.

Some Facts About Solar Energy in Massachusetts

Solar energy can provide a way to combat increasing fuel costs. While some solar systems are expensive to buy, they can save you enough money over their lifetimes to more than justify their high initial cost.

- Solar energy systems do work in Massachusetts. Most areas of this state get 70% as much sunlight as Florida or southern California.
- Long winters and high energy costs make solar energy more practical and economical for use in Massachusetts than in other parts of the country.
- The sunlight falling on Boston on one sunny day could heat 25,000 homes for an entire year.
- Solar heating systems create no pollution and have less fire and safety problems than fossil fuel systems.

Some Facts About Fuel in Massachusetts

One point is clear: Massachusetts is vitally dependent upon existing supplies of fossil fuels such as oil and gas. These fuels are destined to become more expensive.

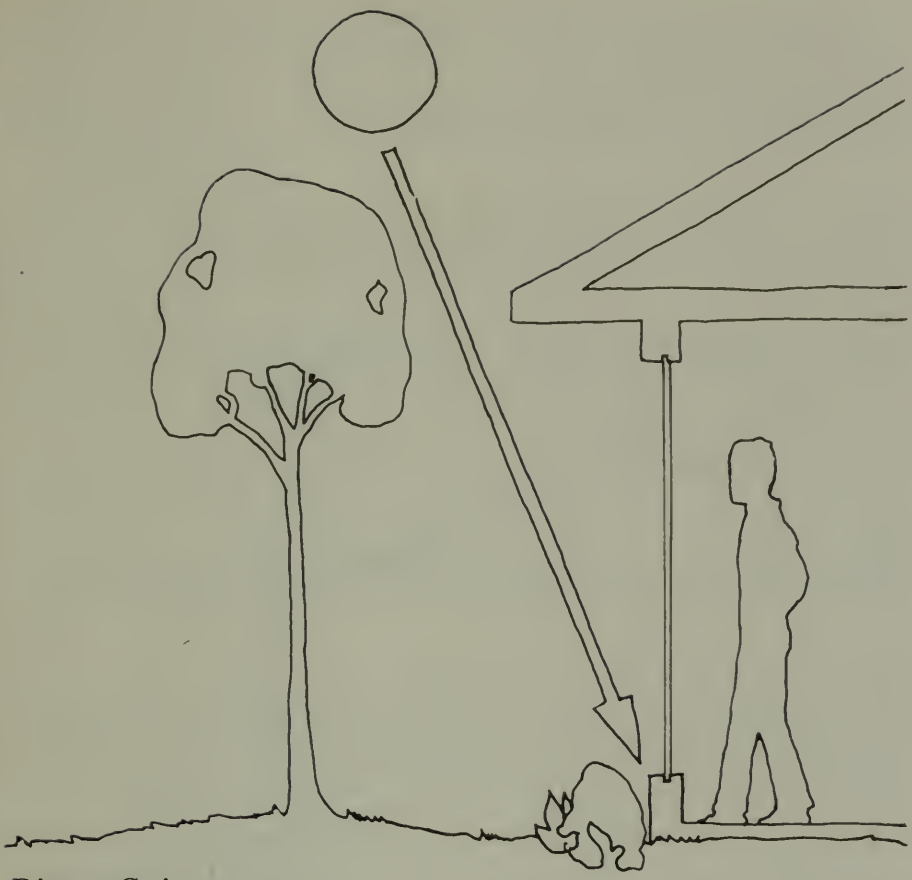
- Oil is the source of 85% of all the energy used in the Commonwealth.
- 60% of the oil used in the Commonwealth comes from foreign sources.
- Massachusetts residents pay 33% more for energy than the national average.
- This incredible dependence on oil is reflected in the cost of energy we use in our homes. 35% of all the energy consumed in Massachusetts is used for space heating.
- The cost of heating the average Massachusetts home has risen dramatically.

Solar Systems For Your Home: How They Work

Solar systems can be used in many ways, from providing hot water and heat for your home, to creating an indoor garden, to generating electricity. The following are just some of the ways that solar energy can be used.

Passive Solar Systems

Passive solar systems heat buildings without the complicated plumbing and machinery associated with other types of solar systems. Passive solar systems are currently the most economical systems to build and use, because they use conventional construction methods and require few moving parts. The basic principle behind passive solar energy is the "greenhouse effect." Sunlight shines through the south facing windows and is absorbed by the building's interior. Appropriate building geometries and shading devices trap the sunlight when heat is needed and exclude it when heat is not desired. Presented below are three passive solar systems. These are the "direct gain" of sunlight through large, south facing windows; the use of a south facing "thermal storage wall;" and the incorporation of a greenhouse into a building's south facing wall.



Direct Gain

This approach works best when the following conditions are met:

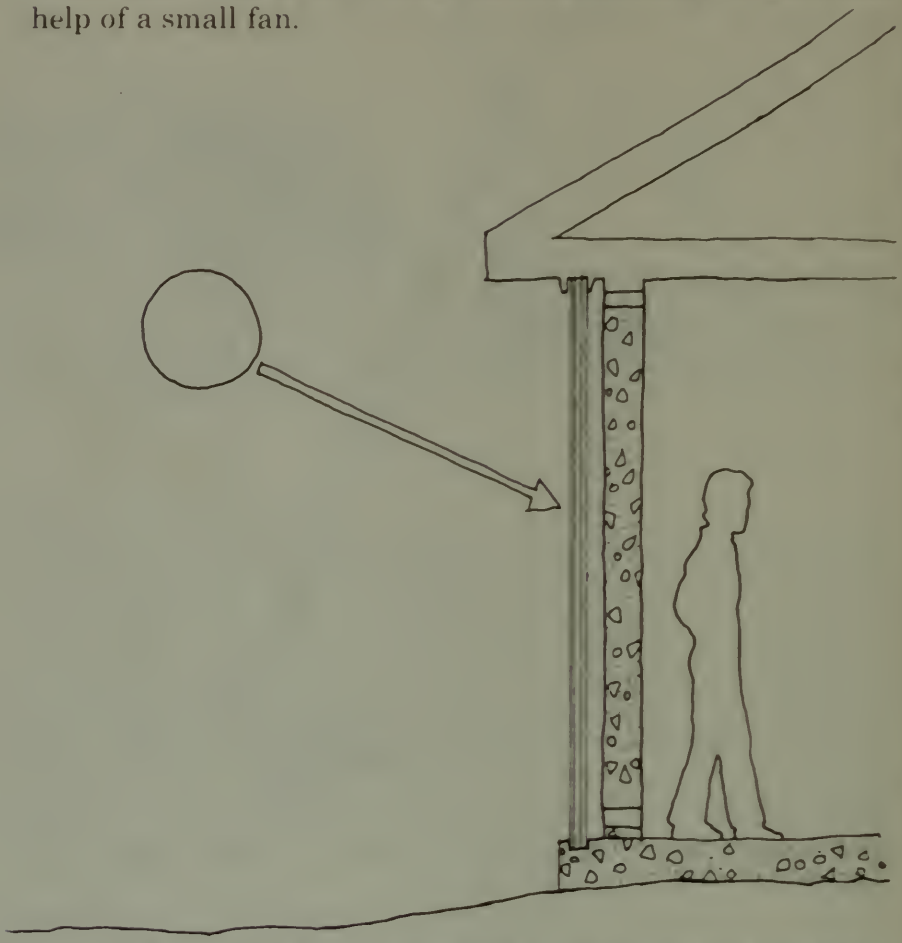
- The south facing windows have two layers of glass (double-glazed).
- The windows have insulating shutters or curtains to keep the heat collected during the day from being lost at night.
- The windows are shaded by roof overhangs or eaves to prevent the summer sun from overheating the building.
- The building is made of materials which can store a great deal of heat (having a high thermal mass), such as concrete floors or masonry walls which are insulated on the outside surface of the building.
- Movable insulation is provided for windows, such as heavy curtains or thermal shutters, to reduce heat loss at night.

Thermal Storage Wall

A thermal storage wall works best when the south facing wall is:

- made of a material which can store large amounts of heat such as masonry, containers filled with water, or phase-changing (eutectic) salts (see Active Collector Systems, Storage);
- painted black or another dark color on the outside surface to absorb the maximum amount of sunlight;
- covered with one or two layers of glazing a few inches in front of the wall's outer surface to minimize heat losses; and

- vented at the top and bottom to allow warm air to circulate by convection (this is known as thermosiphoning) or with the help of a small fan.



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Attached Solar Greenhouses

Solar greenhouses can be attached to the south side of a building to heat the living space and provide a place to grow food year-round.

Solar greenhouses can combine the best features of both the "direct gain" and "thermal storage wall" systems. Sunlight which passes through the greenhouse glazing is used by growing plants, and is also converted to heat which is absorbed by a storage wall or floor. To increase the storage capacity, water-filled drums, phase-changing (eutectic) salts, or a rock storage bed can be put in the greenhouse (see diagram).

The heat storage medium, warmed up during the day, radiates heat to both the main building and to the greenhouse, keeping them warm at night.

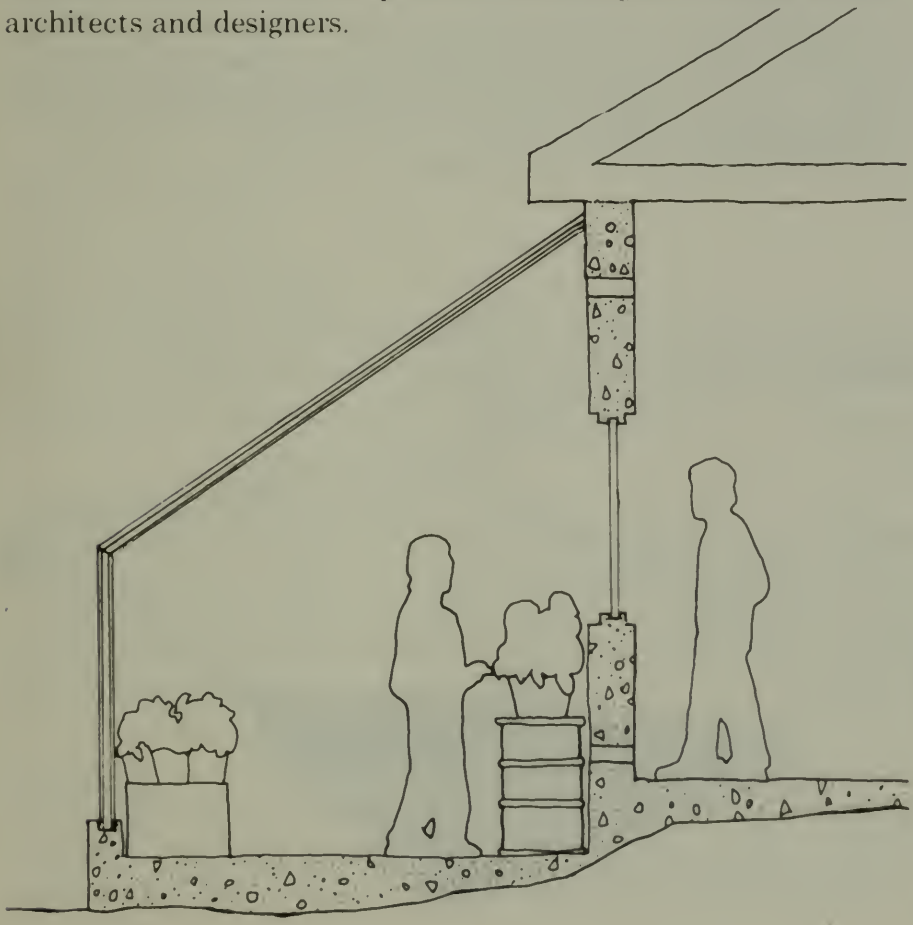
The greenhouse can be built against existing doorways and windows to circulate the warm greenhouse air into the living space (see diagram).

An overhang or other device should shade the thermal storage medium and inside walls to prevent the summer sun from overheating the greenhouse.

At night movable insulation should be placed over the glazing to minimize heat losses.

The east and west walls of the greenhouse are not glazed and should be constructed of masonry which is insulated on the outside.

All of the components of a passive solar system must be carefully designed to work together if such a system is to work well and be economical. The design techniques for passive solar systems are well known today, so that anyone considering building a new home or any type of addition to an existing home should seriously consider a passive solar system. Even for many existing homes, passive systems offer a cost-effective use of solar energy. Additional information on passive solar designs is available from architects and designers.



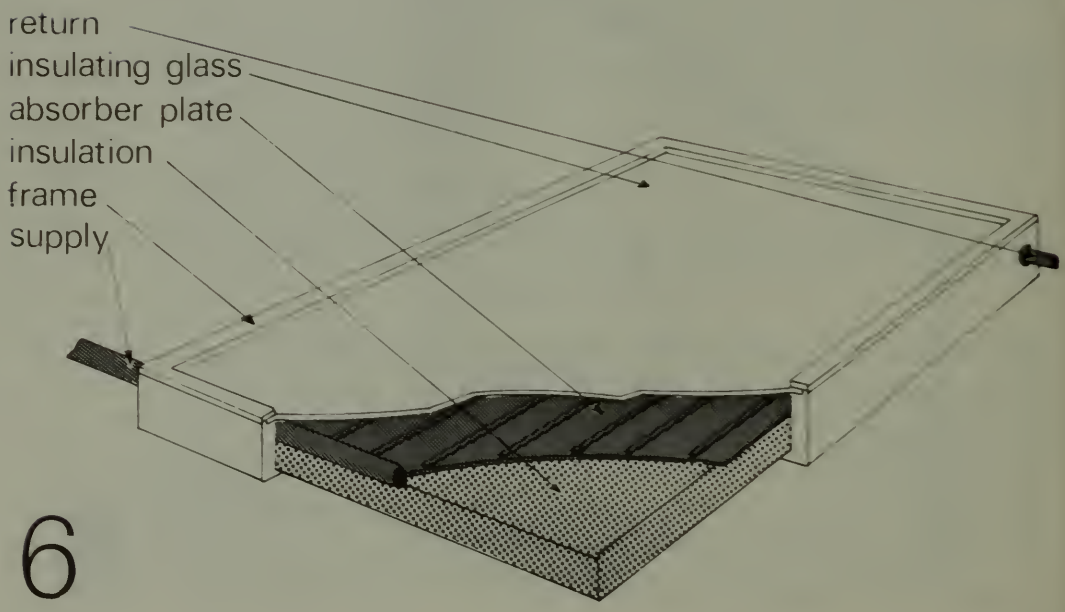
Active Collector Systems

Active solar collector systems are presently the most common type of solar equipment used in homes. Active systems are different from passive systems in that they use electric blowers or pumps and are suitable for heating domestic hot water as well as living space. There are two main types of active collectors, flat plate and evacuated tube. Of these, flat plate collectors are the most common type.

Flat plate collector panels act as a heat "trap." Sunlight passes through the transparent covers of the collector and strikes the absorber plate (see diagram). The heat energy collected in this way is then carried away by a transfer fluid, generally either water or anti-freeze solution, or air. The heat is then stored in an insulated tank or rock bed for use as it is needed.

Evacuated tube collectors trap sunlight in the same way as flat plate collectors except that they are shaped in tubes to withstand the vacuum pressures (see diagram). These collectors have very low heat losses due to the insulating properties of the vacuum. They are more efficient, but they are also more expensive.

In order for active solar systems to perform effectively, it is *very* important that they be installed properly. You will get the maximum energy savings from your solar system provided the following conditions exist:



- The equipment faces within 20° of true south (true south is 15° west of magnetic south). This orientation will maximize direct exposure to the sun throughout the year;
- The collectors are tilted at the optimum angle roughly equal to the latitude (which for Massachusetts is 42°) for domestic hot water heating and the latitude plus 15° for space heating (57°).
- The collector is unshaded between 9:00 am and 3:00 pm all year round. (The sun is at a low point of 24.5° above the horizon in winter, and, in the summer, it is at a high point of 72°.); and
- The system is not oversized or undersized. This is important because equipment that provides too little or too much of your hot water or heating needs may take a long time to pay for itself.

Flat plate collector systems have six major components: collectors, heat transfer fluid, pipes or ducts and their insulation, storage, blower or the pump, and the controls.

Collectors

Each collector consists of one or more transparent cover plates made of glass or plastic (A); an absorber plate, usually made of copper or aluminum but sometimes made of galvanized steel. The absorber plate is coated black or a dark color to absorb the maximum amount of heat (B); insulation, placed behind the absorber plate to keep heat from escaping through the back of the collector (C); the above components are then assembled in a collector case (D).

Heat Transfer Fluid

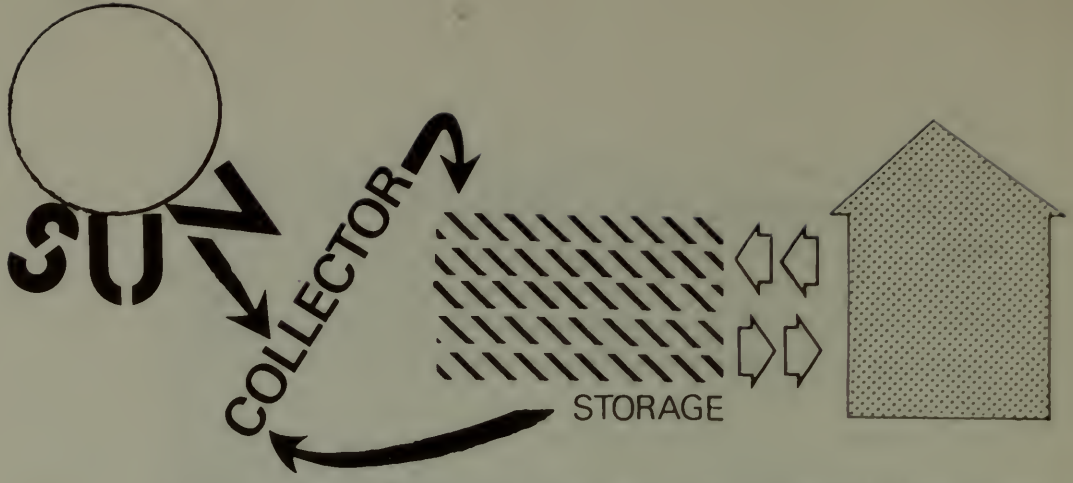
The heat transfer fluid of a flat plate collector may be air, water, or an anti-freeze solution. The advantages and disadvantages of liquid and air systems will be discussed below.

Pipes, Ducts and Insulation

The piping in a liquid solar collector is almost always copper, because it has a high resistance to corrosion. If a collector uses air for its heat transfer medium, the ducts are similar to those found in standard construction. All ducts and piping must be properly insulated.

Storage

The type of storage a solar system uses depends upon whether the heat transfer medium is air or liquid. The three basic types of storage are water, rock, and phase-changing (eutectic) salts.



Rock storage is primarily used with air collectors. One to two inch diameter washed rocks are placed in a bin through which heated air is blown. The rocks store the heat for later use. Rocks do not have as large a heat storage capacity as water, and therefore require a larger volume for a given amount of storage.

Phase-changing salts are commercially available, and can store seven times as much energy as the same volume of water. These salts change from a solid to a liquid state anywhere from 84°F to 120°F, depending on the type and composition of the salts. During this melting process, a great deal of heat energy is absorbed and is released when the liquid turns back to a solid. In addition to being relatively compact, phase-changing salts offer the advantage of absorbing and storing heat at a single, uniform temperature. This property helps reduce losses from storage, and reduces temperature variations in passive solar systems such as greenhouses or thermal storage walls.

Blowers and pumps circulate the air or liquid heat transfer medium throughout the solar system. Many passive systems also use small fans to help distribute the heat they collect.

The controls of a solar system measure the temperature difference between the collector and the storage medium. When the temperature difference is large enough, the controls start the pump or blower which circulates the transfer medium.

Comparison Between Air and Liquid Systems

As mentioned before, there are air and liquid active solar systems. In addition, liquid systems are divided into closed loop or open loop systems. In a closed loop system, the collectors and piping are protected from winter freeze damage by using a non-freezing heat transfer fluid which can safely remain in the collectors even during the coldest weather. Open loop systems use a different approach. The collectors and piping are filled with water which will freeze at 32°F (0°C). Therefore, to protect the collectors and piping from freeze damage, the water drains down well before it reaches this temperature.

Below are listed some advantages and disadvantages of the different systems:

Liquid

Advantages:

- Liquids hold and transfer heat well. Water is currently the most effective heat transfer and storage medium.
- Liquid systems need smaller storage and pipes which will fit where air systems cannot.
- Liquid systems are best for domestic hot water.

Disadvantages:

- The transfer and storage fluid can leak if the system is poorly installed.
- The piping and collectors can corrode due to constant exposure to liquids.
- Freezing, boiling, and excess pressure must be considered.

Air

Advantages:

- Air cannot freeze.
- Damage from leaks is of little concern.
- No boiling or pressure problems can occur.
- Since air is used directly to heat the house, there are no efficiency losses due to transferring heat from one liquid to another.

Disadvantages:

- Oversize ducts (12″ diameter) are needed for the passage of large volumes of air.
- Powerful fans are needed which consume additional electrical energy.
- They are harder to retrofit into existing homes due to space considerations.
- Rock storage requires twice as much volume as water storage.

Liquid Closed Loop

Advantages:

- Small circulator pumps are needed which draw very little power.
- The collectors and piping can be filled with a corrosion inhibitor which will extend the life of the system.
- The protection provided by antifreeze requires no mechanical system to work.
- The most flexible designs and installations are possible with closed loop systems, because they don't depend on gravity to work.

Disadvantages:

- The antifreeze must be checked and replaced periodically.
- They require more parts and high quality workmanship to work well, and therefore are expensive.
- They require either a single or double-walled heat exchanger which somewhat reduces the efficiency of the system.

Liquid Open Loop

Advantages:

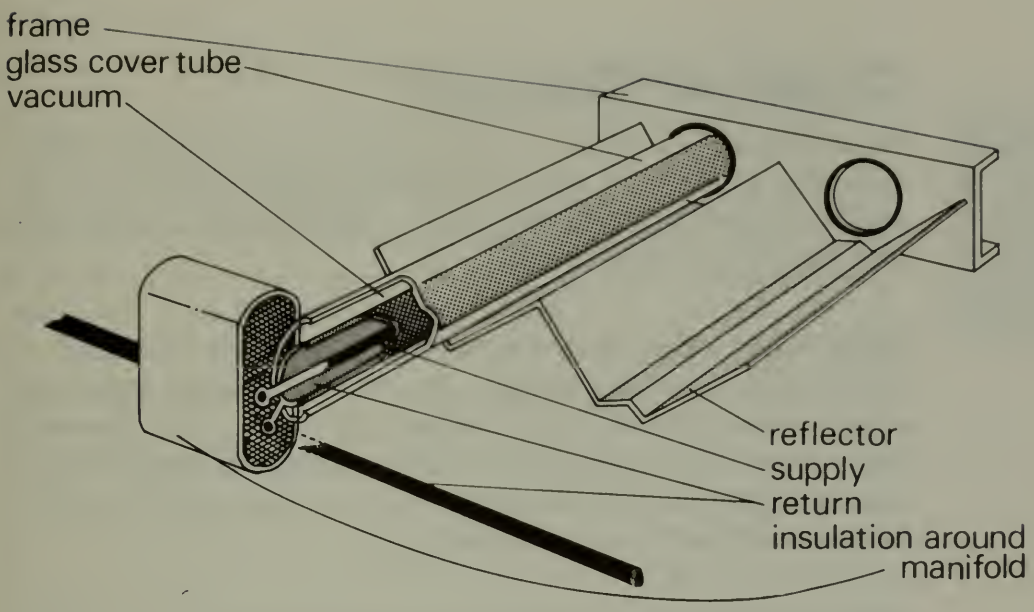
- They use only water in the collectors and piping, so there is no problem with other chemicals leaking into the water supply.
- There are no efficiency losses due to heat exchangers.

Disadvantages:

- Correct sloping of the pipes is critical to prevent water from staying in the system and freezing.
- The draining mechanism must work perfectly all the time to prevent the system from being damaged in freezing weather.

Other Types of Systems

In addition to the above types of solar systems for home use, there are other types of systems described below which are not yet economical or fully practical for general use, but which show considerable promise for use in the near future.

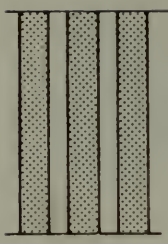


Solar Powered Cooling Systems: Such systems require expensive, high performance equipment to operate. Solar cooling systems use either a mechanical heat engine (such as a turbine) or an adsorption cooling cycle to convert the sun's heat into cooling power for buildings.

Concentrating Systems: Concentrating systems reach very high temperatures by focusing sunlight onto a small area from a larger area. They do this using either curved mirrors or Fresnel lenses. Concentrating systems don't increase the total amount of solar energy you can collect in a given area as there is only a finite amount of sunlight falling on the collector. These systems are generally more useful for industrial processes, such as driving turbines, than they are for heating homes or domestic hot water. This is because concentrating systems can reach temperatures greater than 300°F (135°C)—far too hot for domestic hot water and quite unnecessary for space heating. Also, concentrators must be rotated to follow the sun and keep its rays in focus. To do this, they need expensive tracking mechanisms.

Solar Electric Systems: Solar electric systems use photovoltaic cells to convert sunlight directly into electricity. These cells are generally made of layers of silicone with electric conductors which will generate a current when exposed to sunlight. Photovoltaic systems were originally used to power space satellites and are currently being used on an experimental basis in many remote locations where conventional power is too expensive. With the expected advances in production technology, these systems should be available for use in homes in 10–12 years.

Consumer Question



What follows is a review of some of the most commonly asked questions about solar energy. The rest of this booklet will examine in more detail the economics of solar energy systems and how to shop for them intelligently.

Will a solar system make the outside of my house look ugly?
No. Many people find passively solar heated buildings at least as attractive as conventional buildings. In addition, solar collectors look no more obtrusive than skylights if carefully installed on a roof. You can also install solar collectors separately from the house, in the backyard or on the garage.

Won't those pipes run through my rooms and make the inside of my house ugly?
No. Solar piping in your home should be no more conspicuous than regular plumbing. Besides, many passive solar systems don't use any pipes at all.

Will the rooms underneath the solar panels get unbearably hot?
No. Solar panels collect the heat and transfer it to a remote storage area. They don't magnify it or diffuse it into the rooms below.

Won't I have to tear up the roof to put the solar panels on it?
No. The panels can be installed over the shingles of your roof.

We get lots of snow here. Won't it cover up the panels and make it impossible to use the solar system?
No. The snow will just slide off the collectors, because they have a smooth glassy cover and are tilted to face the sun.

Don't I need a back-up system?
Yes, you'll need some kind of conventional back-up system to augment your solar system on cloudy days.

Should I buy now, or later, when improvements in solar technology have taken place?
Although solar technology is steadily improving, currently available systems are generally of very high quality and perform well. As production volume increases in coming years, manufacturing costs may be reduced somewhat, but rising prices of labor and raw materials may tend to offset this.

Economics of Solar Energy

Solar energy can be a good investment depending on your circumstances. But before deciding to buy solar, you should consider those energy saving investments which are often more economical than solar, such as insulating and weatherizing your home. If you are considering a solar, total-home heating system, your home must be thoroughly insulated, since it is important to save as much of the energy you collect as possible. This means you should provide, at the very least, the equivalent of R-19 insulation in the roof (6″ of fiberglass insulation), R-11 in the walls (3½″ of fiberglass insulation), double-glazed windows and weather stripping. This level of insulation is currently required for new buildings under the Energy Conservation section of the State Building Code. Even greater levels of insulation, R-19 in walls and R-33 in ceilings, are desirable for cold climates like Massachusetts.

If your interest is in a solar domestic hot water system, your water heating bill can also be reduced through insulation. Standard four inch thick fiberglass insulation, wrapped around your hot water tank, can save up to 10% of your water heating bill. Reduced flow shower heads and faucets are also extremely effective in reducing energy costs.

For more detailed information on insulation and weatherization, you can call the Massachusetts Office of Energy Resources at (617) 727-4732 or the Toll Free Energy Phone at 1-800-922-8265.

Another factor affecting the economics of solar is whether you intend to install it in a new or existing home. Solar systems are usually cheaper in new construction. For example, many of the passive solar systems discussed earlier in this booklet can easily be incorporated into the design of a new house, saving you money on your heating and air conditioning bills without drastically increasing the costs of construction. In new homes, active solar systems for both space heating and domestic hot water will be less expensive than in existing homes, since the collectors can be built into the roof as it is constructed, and the pipes or ducts can be installed as the walls are built.

If you are building a new home, and feel you don't want to install a solar system now but may want to in the future, you should consider orienting the house properly on the site (facing south), choosing an appropriate roof slope, and providing space for pipes, ducts and storage as the house is built. This will cut the installation costs considerably when you add the solar system later.

For an existing home, some passive solar techniques are inexpensive, and if properly used, can save you considerable quantities of energy. For instance, if your home already has large south facing windows, you might consider installing insulated shutters or curtains on the inside to prevent heat loss at night.

The following sections deal with the economics of active solar systems. While passive systems are often more cost-effective, we are not treating them in detail here because of their variety.

Energy Savings

The amount of energy you can get from an active solar collector system depends on what you are using it for, the system's efficiency and the quality of the installation. For year-round use, such as heating hot water, it takes about 60 square feet of solar collectors (or three 20 sq. ft. collector panels) to supply one half the hot water needs of a typical family of four in Massachusetts. Such a system will produce yearly the energy equivalent of about 110 gallons of oil, 3,000 kilowatt hours of electricity, or 10,500 cubic feet of natural gas. If electricity is used as the back-up in such a system, the solar system will save you about $138 per year at today's prices.

A combination space and hot water heating system will require more collector area. In order to provide 50% or more of the heating needs of the home as well as most of the domestic hot water needs, such a system should contain about 1 square foot of collector for every 2 square feet of floor area. A typical 1,200 square foot home with about 600 square feet of collector should annually save you 500–600 gallons of oil, or 12,000–15,000 kilowatt hours of electricity, or 40,000–50,000 cubic feet of natural gas.

Costs of Active Systems

A typical solar water heater designed to provide 50% of the hot water needs of a family of four costs $2,500–$3,500 installed. If the solar system is installed on a do-it-yourself basis, you can expect a reduction of about 20–30% from this price. However, you should not install a system yourself unless you have a solid background in construction, plumbing and electrical work. (The Office of Energy Resources has published Solar Water Heater Installation Guidelines for homeowners and professionals. Write or call for a free copy.)

An active solar space heating system designed to provide 50% of the heating needs of a typical 1,200 square foot house will cost about $15,000–$24,000. If the system is effective, and if the installation can be done for a reasonable price, then solar energy may well be less expensive than electric heat for your home. Also, as fuel costs increase and as solar systems improve, solar energy may be the least expensive way to heat your house within a few years.

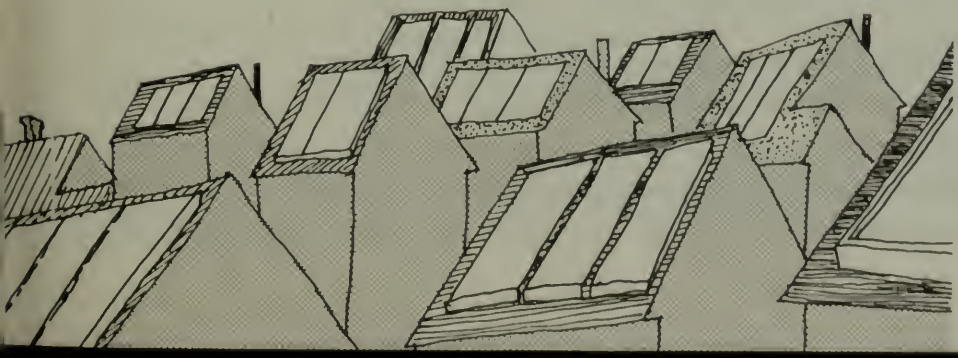
The most economical use of solar energy now is in the heating of domestic hot water, especially where electricity is used as the back-up source of energy.

Although a solar water heater costs 4–5 times as much as a conventional water heater, it costs much less to operate because of the fuel it saves. When comparing a solar water heater and an electric water heater, you should look at the "life-cycle" cost of each system. The "life-cycle" cost simply means the total cost to buy and run the system over a period of years. When the life-cycle cost of solar and conventional water heaters are compared, solar looks like a good investment. The following example will help to show this. (Actual numbers will vary greatly. The figures included here are illustrative only, and may not be accurate for your particular installation.)

EXAMPLE: Mr. E. installs an electric hot water heater for $400 for his family of four. Ms. S. decides to install a solar hot water heater with electric back-up for $2,750 for her family of four. The solar system is designed to provide 50% of her family's hot water needs.

Ms. S. can claim a federal tax credit of $750 (see below) which reduces the price of her solar system to $2,000. Although the initial cost of Ms. S.'s solar water heater is high, her fuel costs over the years will only be half those of Mr. E. As electricity prices grow, this cost difference turns out to be important.

Assuming the average cost of electricity is now 4.6¢ per kilowatt hour and grows at the rate of 8% per year, Mr. E. will pay about $7,400 for electricity over a 15 year period just to heat his hot



water. Ms. S. will pay half that amount. Furthermore, Ms. S.'s system will have paid for itself in 9 years; that is, in the ninth year, her total electricity savings will exceed $1,600 or the difference between her system and the conventional heater of Mr. E. From then on, except for minimal maintenance costs, Ms. S.'s solar system provides her with essentially free energy for one-half of her hot water needs.

Another way of looking at the economics of Ms. S.'s solar system is to compare the two systems from a savings point of view. Suppose that Mr. E. takes the $1,600 he saves by not purchasing a solar system and puts it in a savings bank at 6% interest for 15 years. Suppose also that Ms. S. takes the money she saves in fuel bills from her solar system every year and puts it in the bank at 6%. If you compare the two investments after a 15 year period, it turns out that Ms. S. has over 25% more money in the bank than Mr. E. ($1,600 at 6% compounded for 15 years is $3,930, the value of the cumulative solar savings at 6% for the same period is $4,950). In fact, by investing in solar over this period, Ms. S. has earned 8.2% on her money—clearly not a bad investment at all! The solar system begins to look even better when you consider that it should also increase the value of Ms. S.'s home, without increasing property taxes.

If you would like to find out whether solar makes economic sense in your particular circumstances, you can write to the Office of Energy Resources and ask for a solar economic worksheet which we have prepared. The worksheet will guide you through calculations similar to those used in the example above so that you can determine what your savings might be using a solar water heater.

Low Interest Bank Loans

Most banks in Massachusetts are willing to give loans for solar energy systems right now. Ask them for an energy-saving home improvement loan. Many banks in Massachusetts are offering reduced interest home improvement loans for solar systems and energy conservation measures. They will write loans for solar systems at less than their market rates for regular home improvement loans. For the most up-to-date information concerning participating banks, call the Massachusetts Office of Energy Resources (617) 727-7297.

Tax Incentives for Solar Heating Systems

There are three main tax incentives you should be aware of.

Federal Income Tax Credit: Homeowners and tenants can claim tax credits of up to $2,200 for many types of solar and wind equipment installed on their principal residence. Certain passive

solar systems, such as greenhouses, are excluded under current IRS regulations. A credit of 30% of the first $2,000 expenditure and 20% of the expenditures from $2,000 to $10,000 can be taken. This credit is subtracted from the amount of taxes you pay (not from your net income). There is also a credit of 15% for expenditures on insulation, weatherstripping, storm windows, etc., up to a maximum of $300. You should use IRS Form 5695 to claim these tax credits.

State Sales Tax Exemption: Any equipment relating directly to solar, wind, or heat pump systems for a person's principal residence is exempt from state sales tax (Mass. G.L. C. 64H, Sec. 6).

Property Tax Exemption: The value added to your property by a solar or wind system is exempt from property taxes for a period of 20 years from the date of installation. This applies to businesses and corporations as well as homeowners, new buildings, or retrofits. (Mass. G.L. C. 59, Sec. 5).

Solar Income Tax Credit: 35% up to $1,000 retroactive to January 1, 1979.

Protecting Your Investment

Here are a few tips for potential buyers of solar energy systems. This is not intended to be an all-purpose buyer's guide. Rather, it points out some consumer dangers to avoid and some guidelines to follow to ensure that you get the most value for your solar dollar.

The proof of a product's performance should come from an independent laboratory or university. Ask for a copy of the report itself, not of what the manufacturer claims the report said. An increasing amount of solar equipment is being tested to meet the U.S. Department of Housing and Urban Development (HUD) Intermediate Minimum Property Standards for solar domestic hot water systems which have been approved for use in Massachusetts under the HUD Hot Water Initiative Grant Program. This approval is limited to the HUD program only and does not suggest approval or endorsement for any other purpose. However, if you are considering the purchase of a solar domestic water heater, you might find this list valuable in comparing systems. For a copy of this list, write the Renewable Resources Division. Finally, ask for the names of other people who have purchased solar systems from the manufacturer and check personally with them. Don't forget to check with the Better Business Bureau, as well as local solar energy organizations.

Be careful of sellers who use Post Office box numbers. Although many legitimate businesses use these as a convenient way to receive bills and orders, it is also a common tactic of the fly-by-night operator to use a Post Office box number, operate a territory until the law starts closing in, and then move and take a new name and territory. Find out from the seller where his place of business is and how long he has been there and ask for his financial references.

Solar components are like stereo components—some work well together, some don't. If the system you are considering is not sold as a single package by one manufacturer, you should be sure that your installer knows how to assemble a good solar system.

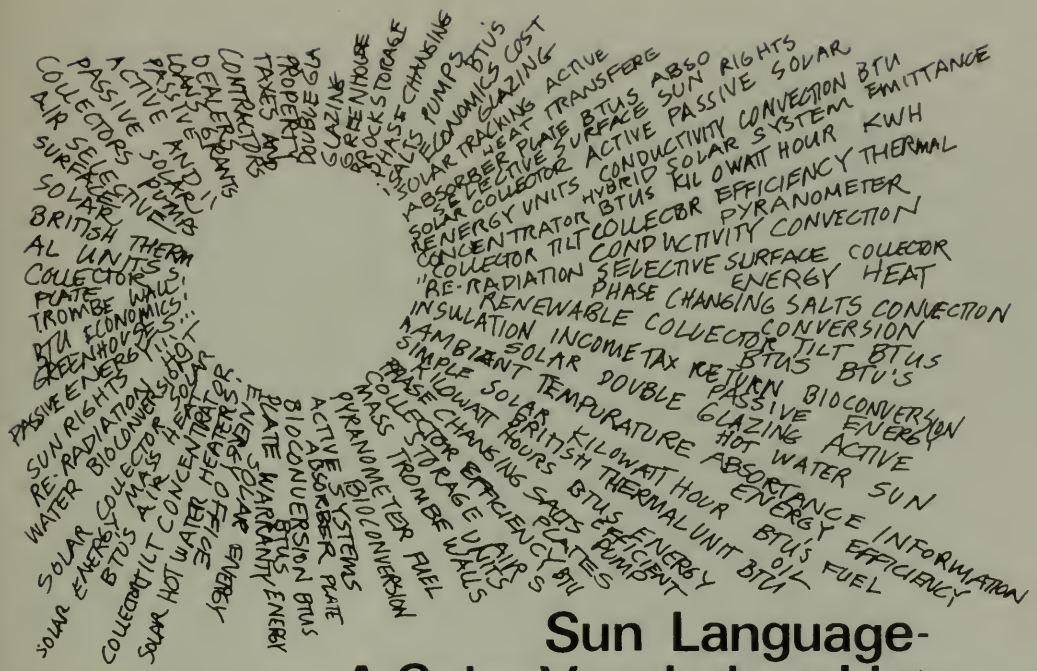
Be sure you know specifically who will service the solar system if something goes wrong. Don't settle for the response that any plumber or handyman will do. Obtain written assurances that specify who will service the system if it fails.

Remember to get a binding written estimate of the installed cost of the solar unit. The installer, not the consumer, should bear the risk of inaccurate estimates of installation costs.

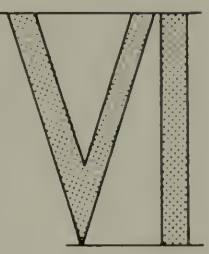
Don't buy solar equipment without getting installation costs included in the contract, unless you plan to install the system yourself. You should only consider installing the system yourself if you have a solid background in construction, plumbing and electrical work.

Before you buy, be sure your solar system is adequately protected by warranty. A strong warranty is an effective way to protect yourself from disappointment. Require a written warranty from the manufacturer. Make sure you understand the provisions of the warranty. Federal law requires that all the conditions of the warranty be stated clearly. Is it full or limited? Which parts of the system are covered and for how long? There should be a five year manufacturer's warranty on the major components of the system, including collectors, heat exchanger and tank. If a professional installer puts in your system, you should also obtain a written warranty from the installer protecting you against failure of the system or any of its components for at least one year. It is important to determine the obligations of the manufacturer and contractor. The manufacturer will normally not provide a warranty against system failure which is caused by defective or faulty installation.

Once you get a solar system, don't change your energy use patterns just because you think you have lots of free energy. Conservation of energy and effective insulation still count if you want to reduce your monthly bills. Don't blame the seller of the solar heating system if you keep your doors and windows open during the middle of the winter.



Sun Language- A Solar Vocabulary List



Absorber, or **Absorber Plate:** A surface, usually blackened metal in a solar collector, which absorbs solar radiation and becomes hot.

Absorptance: The ratio of energy absorbed by a surface to the energy striking it. Black matte surfaces have high absorptances, while white or shiny metal surfaces have low absorptances.

Active System: A solar heating or cooling system that requires the external mechanical power of fans or pumps to move the heat collected by the system.

Ambient Temperature: The outdoor air temperature.

Bioconversion: Use of agricultural or municipal wastes to provide fuel.

British Thermal Unit: (Btu) A unit of energy defined as the amount of energy required to heat one pound of water one degree Fahrenheit. A gallon of fuel oil, when burned in an oil burner, will produce about 100,000 Btu's. A cubic foot of natural gas contains 1,000 Btu's. A kilowatt hour of electricity contains 3,413 Btu's.

Collector Efficiency: The ratio of usable heat energy extracted from a solar collector to the solar energy striking the collector.

Collector or **Solar Collector:** A device which converts sunlight into heat energy. It is made of a number of parts including a cover plate, an absorber plate, back insulation, and an enclosure.

Collector Tilt: The angle measured from the horizontal at which a solar collector is tilted to face the sun.

Concentrator: Reflector or lens designed to focus a large amount of sunshine into a small area in order to increase the temperature in that small area.

Conductivity: The ease with which heat will flow through a material which is determined by the material's physical characteristics. Copper is an excellent conductor of heat; insulating materials are poor conductors.

Convection: When two surfaces, one hot and the other cold, are separated by a thin layer of air, moving air currents (called convection currents) are created which carry heat from the hot surface to the cold.

Emittance: This is the measure of the heat re-radiated from the solar collector's absorber plate.

Galvanic Corrosion: This can result when the heat transfer fluid makes contact with two different metals which are not physically or electrically isolated.

Heat Transfer Fluid: Any substance such as air, water, or antifreeze, used to carry away the heat collected by the absorber plate.

Hybrid Solar System: A system that uses both active and passive methods to operate.

Insolation: The amount of solar radiation striking an exposed surface, often expressed in terms of Btu's per square foot on a horizontal surface. In Boston, the average insolation is 1,110 Btu's per square foot per day.

Kilowatt: (Kw) One thousand watts of power, equal to $1\frac{1}{3}$ horsepower.

Kilowatt-Hour: (Kwh) The amount of energy equivalent to 1 kilowatt of power being used for one hour (or 3,413 Btu's).

Passive Solar System: A solar system which uses little or no mechanical energy to operate. (See detailed description in text.)

Photovoltaic: This refers to the direct conversion of the sun's energy into electricity, usually by means of a device called a photovoltaic or solar cell, often made of silicon.

Pyranometer: An instrument for measuring solar radiation.

Radiation: Any object that is warmer than its surroundings radiates heat waves (similar to light waves but invisible) and thus emits heat energy called radiation.

Re-radiation: The heat emitted by a warm collector plate to its cooler surroundings.

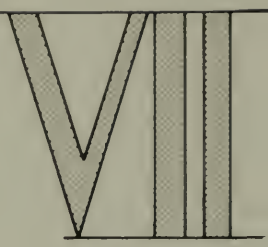
Selective Surface: A special coating sometimes applied to the absorber plate in a solar collector. The selective surface absorbs most of the incoming solar energy and re-radiates very little of it.

Solar Tracking: Adjusting a solar collector so that it always faces the sun squarely.

Sun Rights: (or Solar Access) A legal issue concerning the right of access to sunlight.

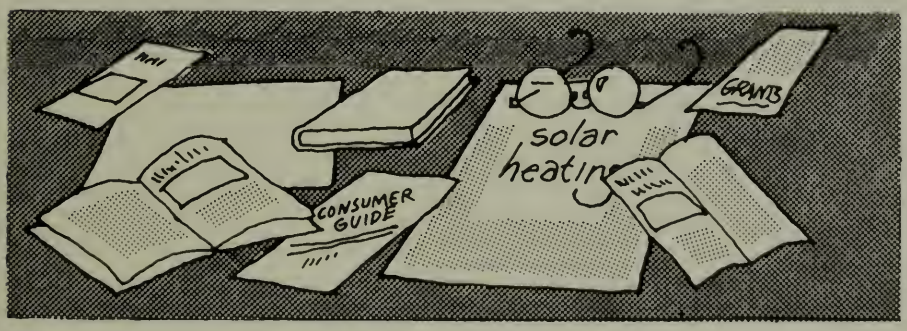
Therm: A measure of energy equal to 100,000 Btu's.

Information List



The following is a list of information available from the Massachusetts Office of Energy Resources.

- The Solar Energy Economic Worksheet to help me figure out the costs and benefits of solar energy for my home.
- A list of solar legislation in the state.
- A list of solar energy firms including: 1) manufacturers, 2) dealers, distributors, and manufacturer's representatives, 3) architects and engineers, 4) builders, 5) installers, and 6) researchers.
- A list of solar hot water systems approved for use in the HUD Grant Program.
- Solar Water Heater Installation Guidelines, to help me install a solar water heater system and avoid the common installation errors.
- A Passive Solar Energy Booklet, to give me passive energy ideas and information about its economic benefits.
- A Solar Consumer Protection Pamphlet, to show me how to shop for solar and avoid consumer mistakes.
- A Solar Energy Grants Guide, to show me where and how to apply for solar grants.
- A poster called "Simple Solar Heating."
- A sheet explaining financing options for solar residential construction.
- Solar energy bibliography.



If you would like to receive copies of any of these materials, call or write:

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